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THE

HICKOK

ELECTRICAL
INSTRUMENT
COMPANY

SERVICE MANUAL
FOR
HICKOK CARDMATIC
MODEL 123 — 123A

CHOICE OF THE EXPERTS
FOR SPEED, ACCURACY
and DEPENDABILITY...

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Service Manual
for
Model 123 and 123A Instruction Books

The following notes and procedures generally pertain to servicing which can be accomplished in the field. Should trouble persist, contact the factory, giving nature of trouble. Instructions will then be given for correcting the trouble or returning the equipment.

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HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 Dupont Avenue Cleveland 8, Ohio

Trouble Shooting

SYMPTOM	PROCEDURE
Test 6 or 7 cannot be adjusted	Check 1/4 amp. fuse (See Service Note #5). Replace if necessary, Check #68 lamp. Replace if necessary. If trouble persists, replace 1N91 crystals - Hickok Code #3870-39. (See Service Note #6)
Meter slams on 6BQ6 Test card #4 reads full scale	Replace 20 ohm 1% shunt resistor R-213, Hickok Code #18539-2. This resistor is mounted on module board (See ~~figure #9~~ and Service Note #11. Service note #11
Short lamps flash during test for damper tubes such as 6W4, 6AX4, 12AX4, etc. Flashing continues if tube is removed from socket.	Temporary procedure: Reduce short test sensitivity by adjusting potentiometer #9 until lights do not flash. See Service Note #4 for permanent correction of this difficulty.
Damper tubes 6W4, 6AX4, 6AU4 read high. Possible arcing within tube. Relay may kick out.	Check 4 mfd 400 volt capacitor. If this unit is shorted replace with 4 mfd 600 volt capacitor Hickok Code Part No. 3105-226. See Service Note #7.
Cannot adjust using card #2, #3, #4, 100 ohm resistor in grid of 6AU6 or 6DQ6A burned.	Check .1, 200 volt capacitor. If shorted replace with 400 or 600 volt unit. See Service Note #7.

SERVICE NOTE No. 1

Calibration Potentiometer Adjustments

1. Potentiometers #5 and #10 set the signal amplitude and signal voltage regulation.

a. Connect the instrument to the line thru a Variac set to 115 Volts. Turn instrument on.

b. Insert a 6L6 card in switch.

c. Connect a high impedance, sensitive AC voltmeter from pin 5 to pin 8 on any convenient one of the tube test sockets. (See Figure #1).

NOTE: THIS MUST BE A HIGH IMPEDANCE AC VOLTMETER CAPABLE OF ACCURATE MEASUREMENT OF 0.22 VOLTS AC. BALLANTINE MODEL 300 OR EQUIVALENT IS RECOMMENDED.

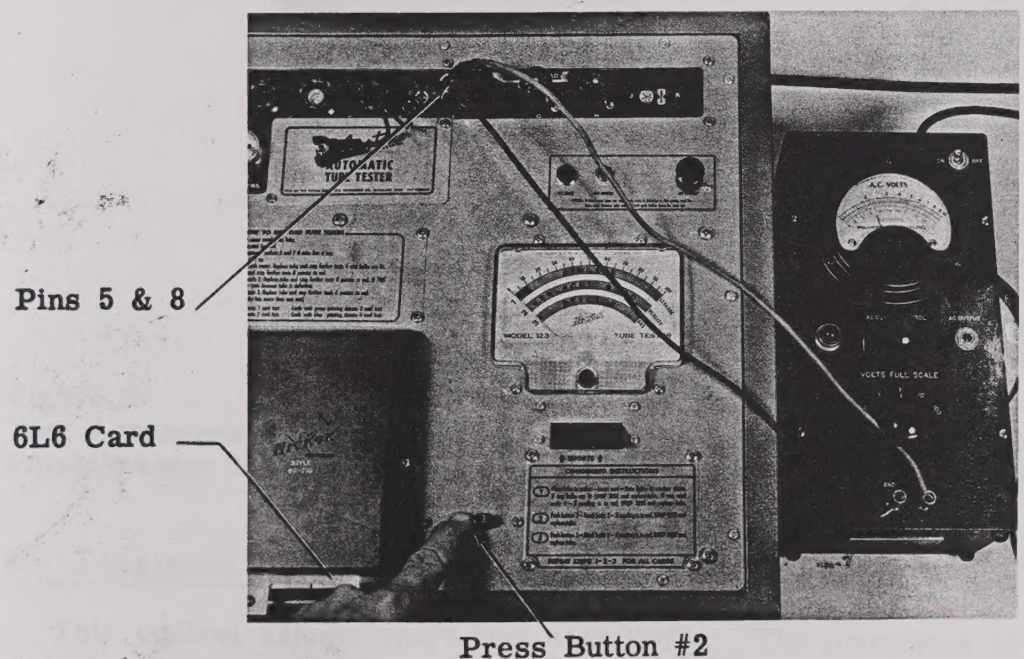


Figure 1
Signal Regulation And Amplitude Test Arrangement

d. Check voltage regulation as follows:
While holding down button #2, vary the line voltage from 105 to 125 volts Note the reading indicated on the voltmeter. The signal voltage at 105 and 125 should be the same. The signal voltage at 115 should not vary over 1% from the 105 and 125 readings.
If the circuit is not regulating in this manner, adjust potentiometer #10 and rock the line voltage until the desired regulation is indicated on the voltmeter. The exact value of the signal voltage during this regulation adjustment is not critical.

e. After the signal regulation is properly adjusted, the exact signal level of 0.22 volts r.m.s. is set by adjusting potentiometer #5.

2. Calibration of potentiometer #8

This control adjusts the cut-out level of the high sensitivity coil of the overload relay. It is adjusted as follows:

a. Insert test card number 4 in card switch. Place a short circuit from pin 3 to pin 6 on any convenient tube test socket. See Figure #2. Adjust potentiometer #8 until the overload relay kicks out when button #2 is pushed. When adjustment is complete remove short circuit. Try with 300-Ω Resistor Should NOT Pop Up.

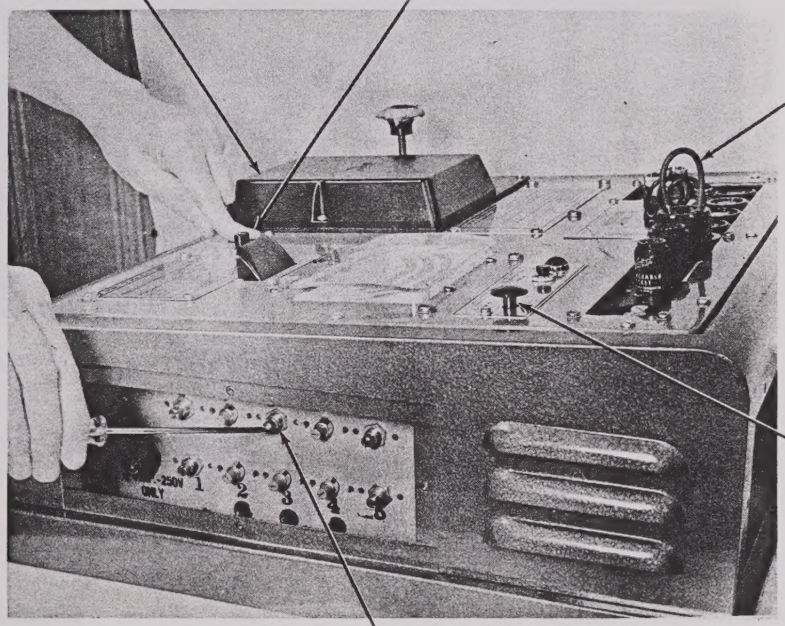


Figure 2
Test Arrangement For Adjusting Potentiometer No. 8

3. Adjustment of potentiometer #9.

This control adjusts short test sensitivity. The procedure is as follows:

a. Turn tester on.

b. Insert 12BY7 card in card switch.

c. Connect a 10 megohm resistor from pin 1 to pin 2 on any convenient tube test socket. (See Figure #3).

d. Adjust potentiometer #9 until neon short lamps 1 through 4 just flicker on and off. Lamp 5 will not flicker.

e. Connect a 20 megohm resistor in place of the 10 megohm used above. All lamps should be completely out. If glow is observed repeat the last two steps.

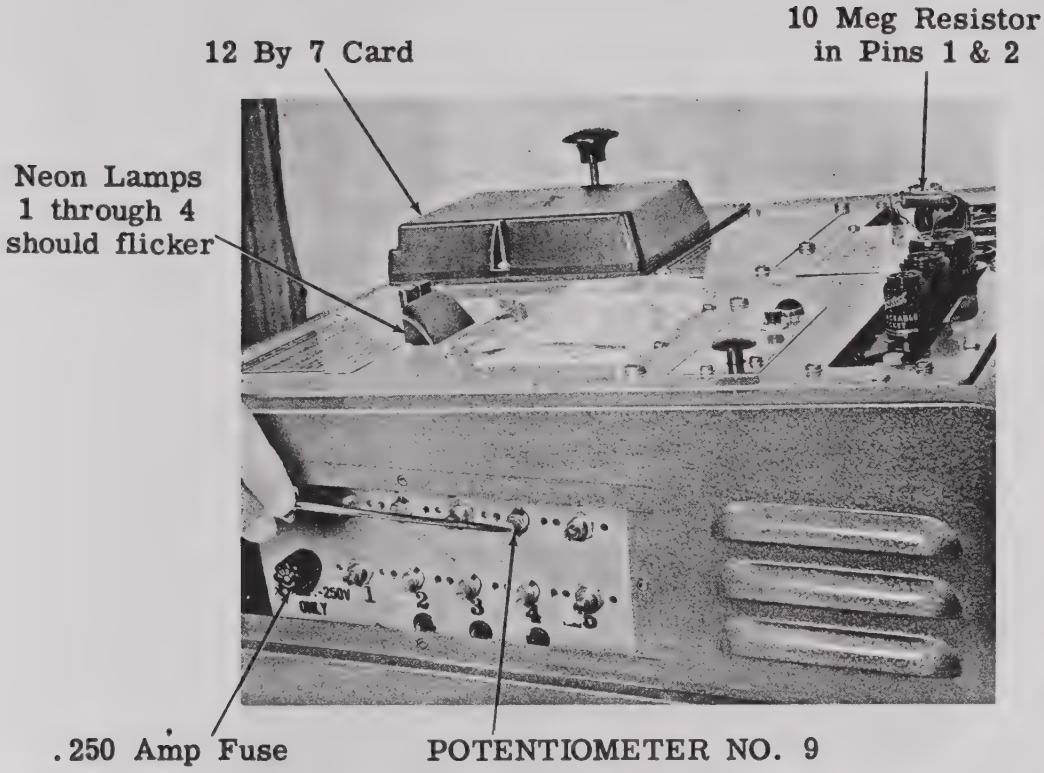


Figure 3
Test Arrangement For Adjusting
Short Test Sensitivity Potentiometer No. 9

SERVICE NOTE No. 2

Checking B+ Voltages

The regulated B+ voltages are normally checked on the instrument by use of test cards #2 (50 volt supply), #3 (100 volt supply) and #4 (150 volt supply).

If one or more of these tests does not give a mid-scale reading on the panel voltmeter and the associated potentiometer cannot be adjusted, the source of trouble may be isolated as follows:

Connect an external voltmeter from pin #3 to pin #6 on one of the tube test sockets (any one of the test sockets may be used according to convenience).

If the external voltmeter agrees with the panel meter that the power supply cannot be adjusted, then the trouble lies in the power supply itself. Check power supply tubes, and appropriate power supply socket voltages. (See Service Note #9).

If the external meter shows the power supply to be properly adjusted while the panel meter shows an appreciable error, then the trouble lies in the meter or shunting system.

Use Shunt resistor test cards to check metering system (See Service Note #11).

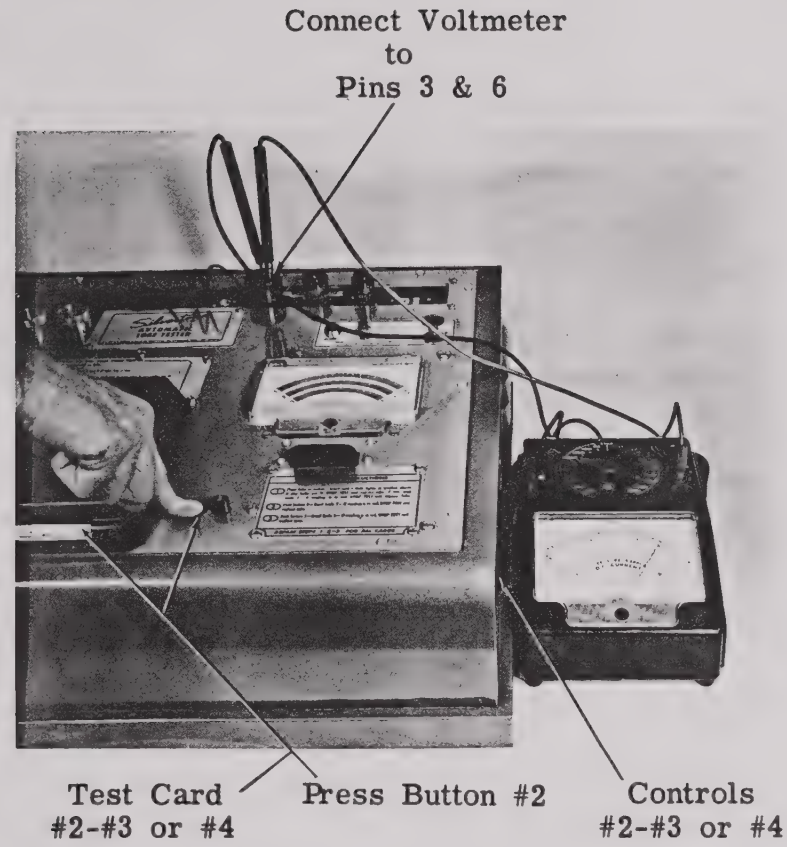


Figure 4
Checking B+ Voltages With An Extermal Voltmeter

SERVICE NOTE No. 3

Tolerances on Tests #6 and #7.

Test cards 6 and 7 are used to zero balance the Gm bridge circuit at high current levels and low current levels respectively. These controls require occasional checking and adjustment to assure maximum accuracy in Gm readings. However, a certain amount of drift from zero is permissible without introducing appreciable errors.

During these calibration tests the meter has a high sensitivity. On test #7 a drift of 10 meter divisions from zero is equivalent to 50 micro-ohms. This would represent only a 1% error on a typical 5000 micro-ohm tube reading.

If very accurate readings are desired on the low Gm tubes (500 to 1000 Gm) it would be advisable to check the zero balance calibration just before the tests are made. However, in general testing this procedure is not necessary.

In actual practice it is usually best to adjust these controls in reverse order. In other words, check and adjust potentiometer #7 first, then adjust potentiometer #6.

SERVICE NOTE No. 4

Modification of Short Test

(This modification is incorporated in all latest production units)

To attain greater short test stability, the following simple modification is recommended:

1. Carefully remove tester from case.

2. Remove the two white wires soldered to pin #1 of the OA2 tube socket and coming from the power transformer. (In some cases these wires appear to be yellow due to the transformer varnish.

3. Solder these two wires to the panel ground lug on the nearest terminal strip (see figure #7).

4. Readjust short test sensitivity as follows:

   a. Connect tester to 115V line.

   b. Insert 12BY7A card in card switch.

   c. Connect a 10 megohm resistor from pin #1 to pin #2 on the 9 pin tube socket (Socket G).

   d. Adjust potentiometer #9 until neon short lamps 1 through 4 just flicker on and off. Lamp 5 will not flicker.

   e. Connect a 20 megohm resistor in place of the 10 megohm used above. All lamps should be completely out. If glow is observed repeat the last two steps. (See figure #3)

SERVICE NOTE No. 5

Fuse Protection for Gm Bridge

In some of the early instruments the 1/4 amp protection fuse for the Gm bridge circuit is wired in the circuit underneath the front panel. In all later production this 1/4 amp fuse is mounted in a fuse holder mounted next to potentiometer #6. (See figure #3) This fuse should be checked first in case of difficulty on test cards 6 and 7.

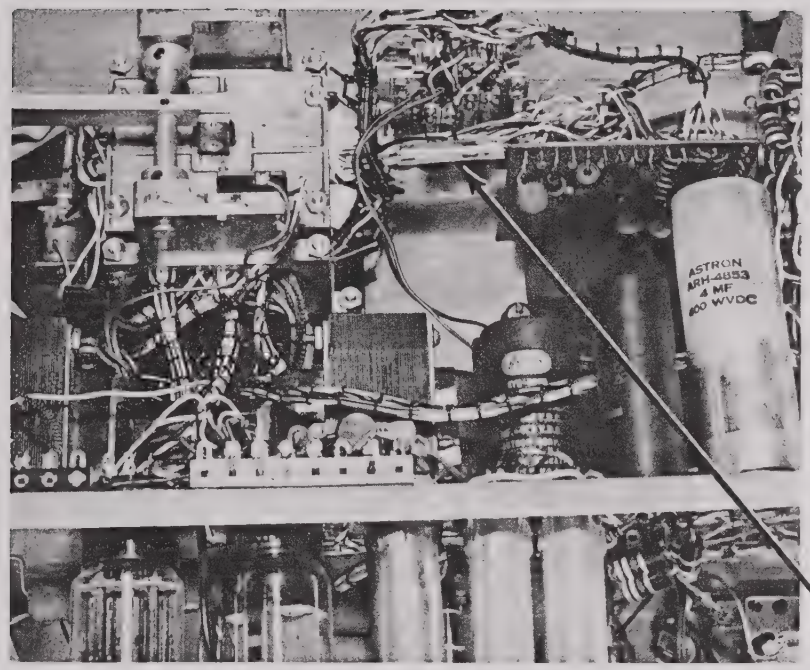


Figure 5
1/4 Fuse Location On Earlier Production Units

SERVICE NOTE No. 6

Replacing 1N91 diodes use SD91

If it becomes necessary to replace the 1N91 diodes mounted on the module board the following points should be kept in mind.

1. The crystals supplied in the original equipment are matched units. They are either two matched pairs or all four are matched together. Replacements should also be matched units. These are available under Hickok part Code No. 3870-39.

2. When replacement is made the crystals must be physically mounted in the same manner as the ones that are removed. This arrangement is shown on the Printed Circuit Board Component Layout sheet, Fig. #7.

3. Care should be taken not to overheat the crystal during the soldering operation. It is suggested that the lead wire be held with pliers between the crystal body and the point being soldered (THIS IS VERY IMPORTANT!)

PRINTED CIRCUIT BOARD
COMPONENT LAYOUT

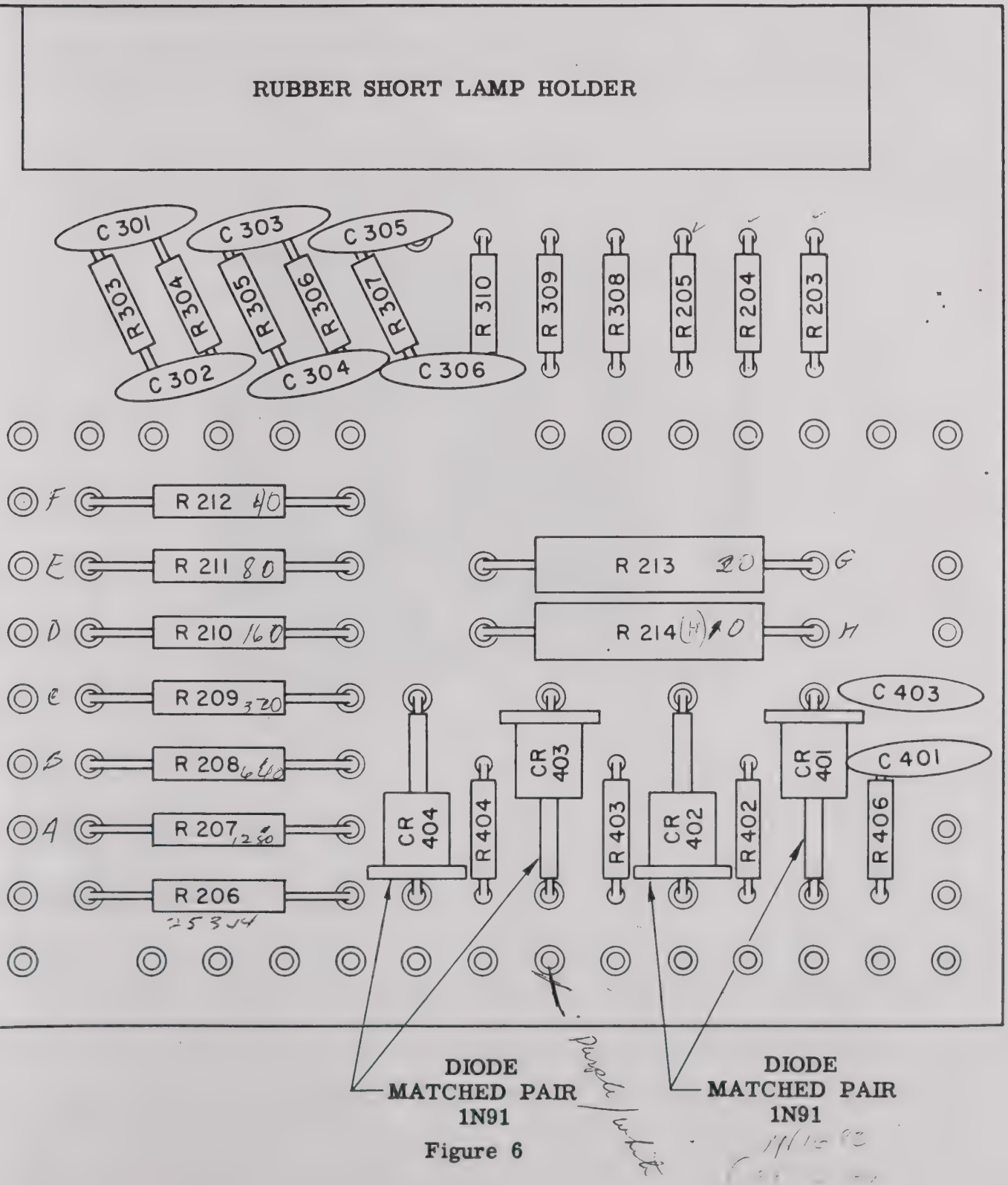


Figure 6

SERVICE NOTE No. 7

Condenser Replacement

(The following information applies only to early production units. These changes are incorporated in later production).

When replacing the 4 mfd capacitor, a 600 volt unit should be used. This is Hickok part No. 3105-226. DO NOT USE AN ELECTROLYTIC CAPACITOR AS A REPLACEMENT.

When replacing the .1 mfd, 200 volt capacitor, a good quality .1 mfd 400 or 600 volt unit should be used. These can be obtained from a local electronic parts distributor or from the factor, Hickok part Code No. 3105-209.

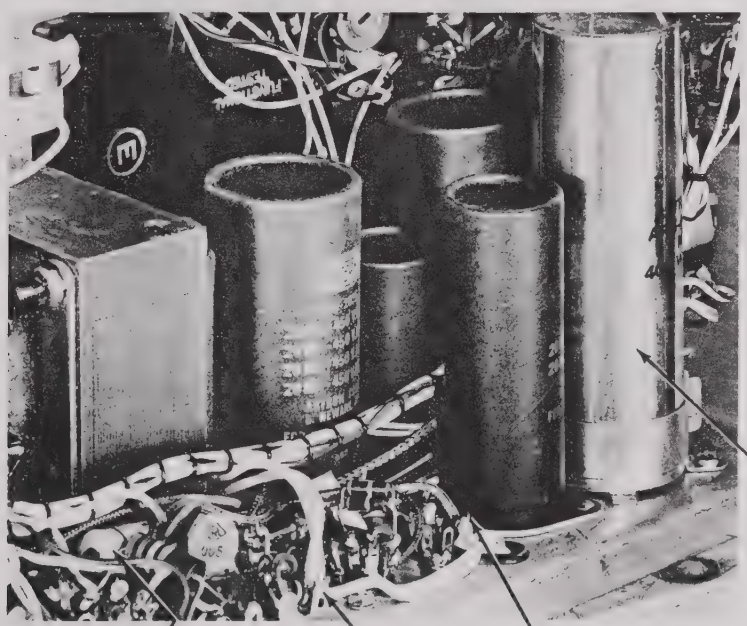


Figure 7
Location Of .1 MFD And
4 MFD Capacitors

SERVICE NOTE No. 8

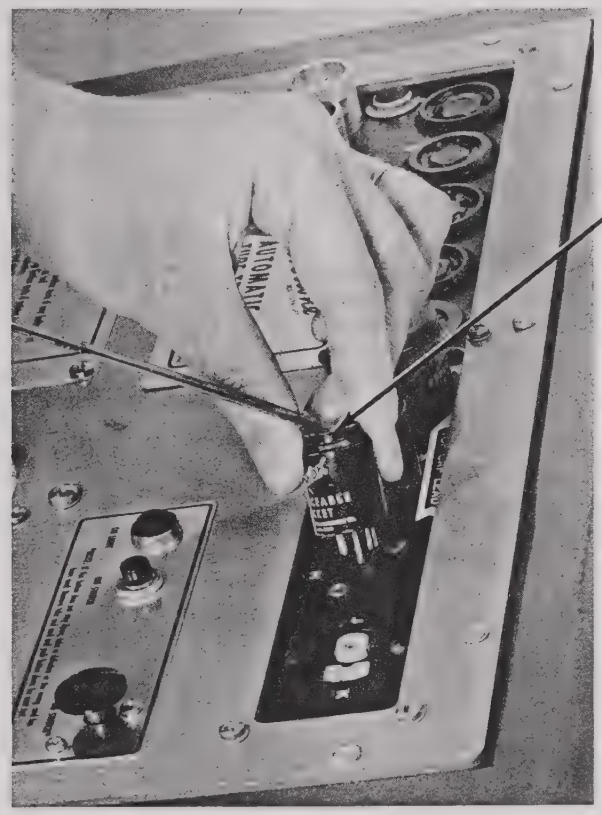
Replacing Socket Savers

Replaceable socket savers are mounted on the equipment for the octal socket and 7 and 9-pin miniature sockets. These sockets have been specially machined so that the "Savers" can be changed from the top of the instrument panel.

THE INSTRUMENT DOES NOT HAVE TO BE REMOVED FROM ITS CASE TO CHANGE THE SOCKET SAVERS.

Socket Savers are available from local Hickok distributors or from the factory, Hickok part code #1050-60.

SOCKET SAVER



Socket Saver Removed By Loosening Screw

Figure 8
Replacing Socket Savers

SERVICE NOTE No. 9

Power supply tube socket voltage chart

The following chart indicates the nominal voltages present on the pins of the power supply tubes during checks with test cards 2, 3, and 4. These voltages should be read with a 20,000 ohms/volt voltmeter and are all referred to pin #1 of the OA2 socket as zero potential for "Ground". The chassis of this instrument is not electrical ground. Input voltage to the instrument should be 115 VAC.

SOCKET CONTACTS

Tube	Test Card	1	2	3	4	5	6	7	8	9
	2	0	- 145	NC	NC	NC	NC	- 145		
OA2	3	0	- 145	NC	NC	NC	NC	- 145		
	4	0	- 145	NC	NC	NC	NC	- 145		
	2	215 AC	NC	HTR	HTR	50	215AC	101		
6X4	3	215 AC	NC	HTR	HTR	50	215AC	101		
	4	215 AC	NC	HTR	HTR	52 * 50	215AC	103 101*		
	2	0	-1.05	145	HTR	HTR	0	-4.2 * -4.4	180 * 185	69 * 76
6AU8	3	0	-1.05	145	HTR	HTR	0	-2.1 * -2.5	145 *150	35 * 43*
	4	0	-1.05 *-1.03	145	HTR	HTR	0	-5.5 -6.0	210 *195	100 * 140*
	2	-1.05	HTR	-34 *27	345 *340	-170 *-135	NC	HTR	52	
6DQ6	3	-1.05	HTR	+35 *43	345 *335	+ 35 *+ 44	NC	HTR	102	
		-1.05 *-1.25	HTR	+102 *140	345 *275	+102 *+140	NC	HTR	150	
	2	NC	FIL	59	250AC	0	250AC	365AC *360	FIL	
5U4	3	NC	FIL	59	250AC	0	250AC	362AC *352	FIL	
	4	NC	FIL	59 *57	250AC *245	0	250AC *245	360AC *290	FIL	

All readings taken with a 20,000 ohms per volt meter

Voltages at socket contacts (Power Supply) with zero volts as reference point.

Pin #1 of OA2 socket = Zero
Input = 115 Volts

***Button 2 pressed**

SERVICE NOTE No. 10

Overload Relay - Checking and Adjustment

1. Preliminary checks

a. Carefully remove tester from case.

b. Determine that the relay coils are not open by checking between terminals 1 and 3 for approximately 100 ohms resistance and terminals 2 and 3 for 0.5 ohms resistance.

If either winding is open a new relay may be obtained from the factory, Hickok Part Code No. 18400-6.

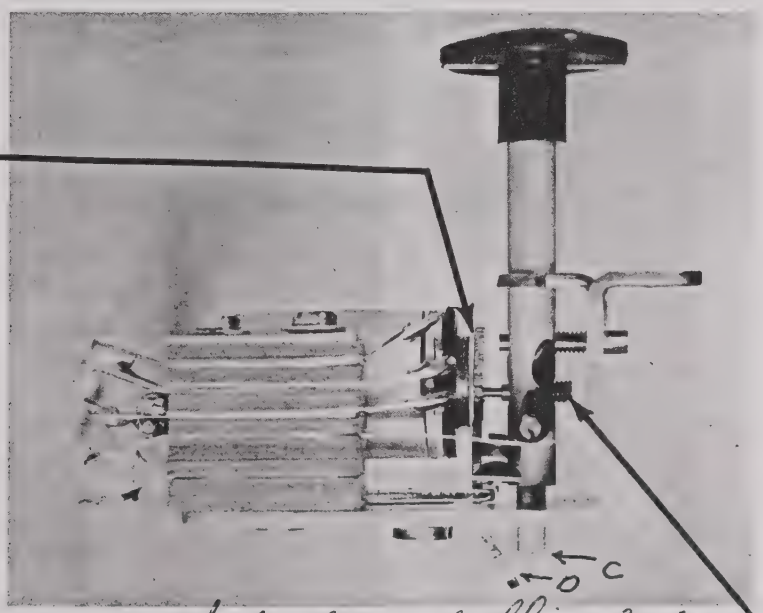


Figure 9
Relay Shown In "up" Position

C. End of plunger should just clear point D. This aids the latch to release the holding current.

The mechanical and electrical adjustments described below are intended to be performed without removing the relay from the instrument. The procedure is substantially the same to check a relay outside the equipment, if desired.

2. Mechanical Adjustment

a. With the relay up, check that the air gap is set to .006 inches by use of proper feeler gages. (See Fig. #9) Air gap can be reset by adjusting lower screw "B". The glyptal sealing the adjusting screw should be softened with thinner before resetting. The screw should be resealed with glyptal after adjustment.

b. With the relay in the down (engaged) position, check that the end of the lower screw "B", is in line with the inside edge of the armature. Any required adjustment is accomplished with the upper screw "A". Soften glyptal with thinner before adjustment and reseal with glyptal after adjustment as before.

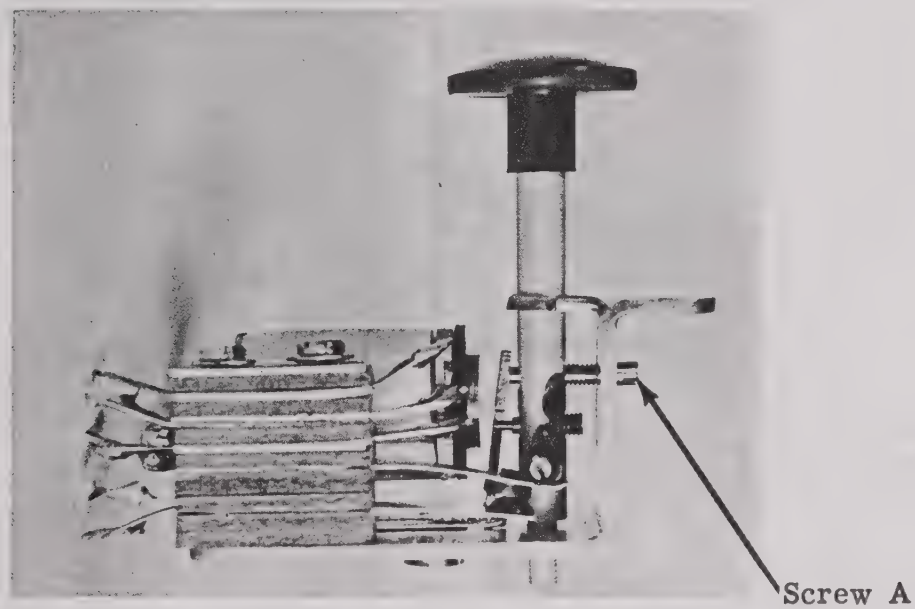


Figure 10
Relay In Down (Engaged) Position

3. Electrical Adjustment

Pull Plug!

a. Connect a temporary short circuit between the two terminals as indicated in Fig. #11.

b. Connect the line cord in series with a 0-5 amp. AC ammeter to a variable source of low voltage AC. (See Fig. #11). This source can be a variac or preferably a variac in the primary of a step down transformer. A filament transformer is suitable for this purpose.

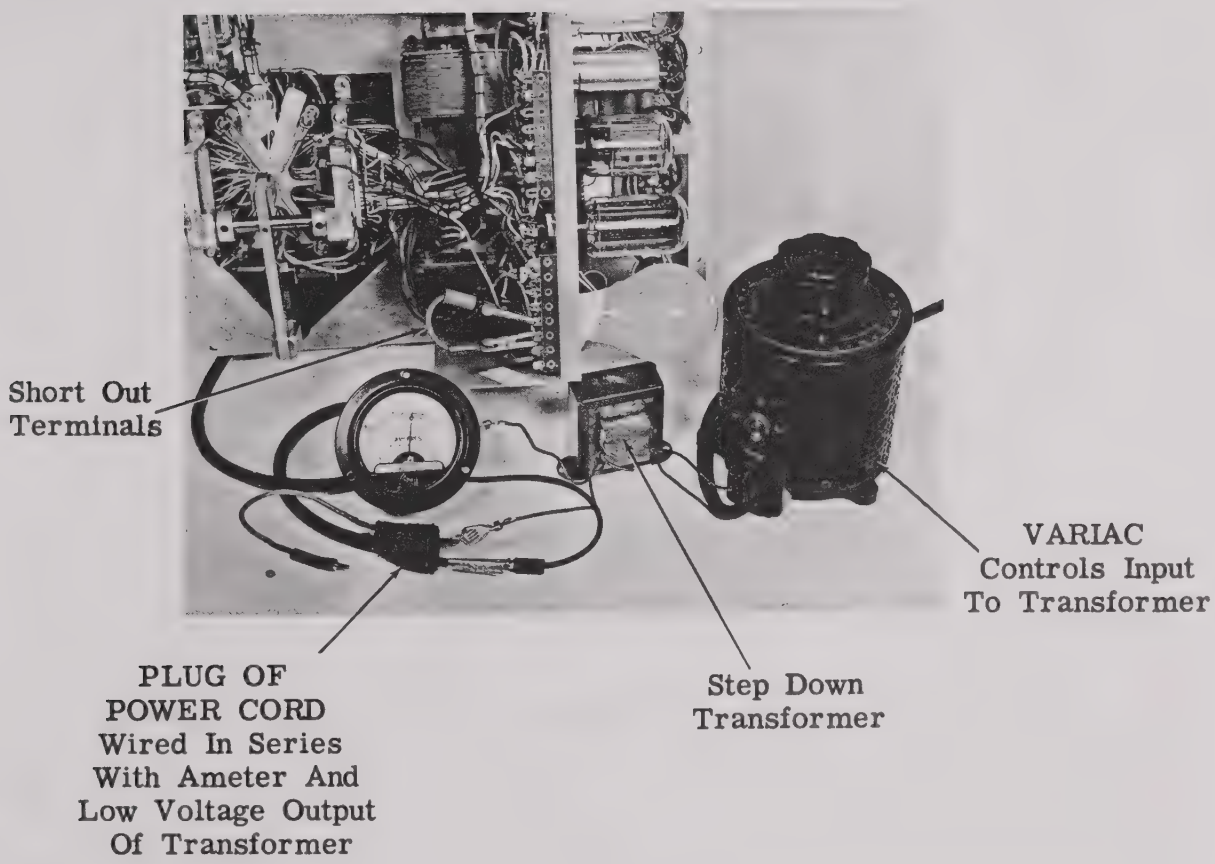


Figure 11
Test Circuit For Electrical Adjustment Showing Temporary Short Circuit

c. Slowly increase the current to the tube tester by raising the output voltage from the variac. The overload relay should "kick out" between 3.0 and 3.2 amps. AC.

d. If the relay kicks out below 3.0 amps AC, increase the tension on the spring by turning lug "C", figure #12. Recheck and readjust spring tension until relay kicks out within proper limits.

e. If the relay kicks out above 3.2 amps AC, decrease tension on the spring by turning the lug until desired setting is reached.

f. Be sure to lock spring adjustment with glyptol after resetting.

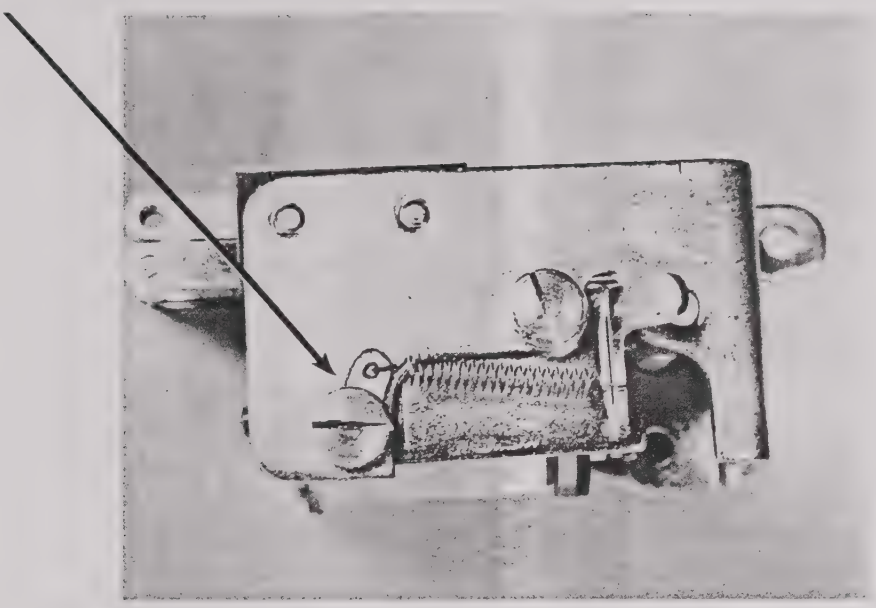


Figure 12
Bottom View Of Relay Showing Spring Adjustment

SERVICE NOTE No. 11

Meter Shunt Test Cards

Eight special meter shunt test cards are enclosed with this manual. These cards are intended to facilitate the location of possible defective meter shunt resistors. Each card checks one meter shunt resistor. The normal readings while pushing button 2 should be approximately mid-scale on the meter. If the shunt resistor is open or shorted, the meter will read toward zero or almost full scale and that resistor should be replaced. Latest model instruments have a 0-100 scale on the meter dial. A meter reading between 45 and 55 with any of these cards is satisfactory.

The shunt resistor test cards are identified as A, B, C, D, E, F, G, and H.

Replacement shunt resistors may be obtained from the factory under the following code numbers which are listed in their proper relationship to their test card.

Test Card	Replacement Resistor Code No.
A	18537 - 72
B	18537 - 71
C	18537 - 70
D	18537 - 31
E	18537 - 69
F	18537 - 68
G	18539 - 2
H	18539 - 7

The location of these resistors is shown on figure #6.

A	R-207
B	R-208
C	R-209
D	R-210
E	R-211
F	R-212
G	R-213
H	R-214

SERVICE NOTE No. 12

TESTING OF DIODE TYPES AND OZ4 RECTIFIER TUBES

-OZ4-

The testing of some OZ4 type tubes may cause the protective relay to operate and shut off the tester.

This condition is nothing to be alarmed at, as the high ionization current necessary to ionize this tube may be great enough to trip the protective relay. All that is necessary is to reset this relay several times or to hold the relay button down until the tube has ionized. The test can then be made in a normal manner, and the tube will test properly and not trip the relay switch.

-DIODES-

The characteristics and test specifications of Diodes are such that a very good Diode may cause the meter to go to extreme full scale hitting the stops at the end. This is a normal condition, as the rejection point in comparison to the possible full current rating of a good Diode is such that this condition exists. Diodes must be down approximately 85% to be classed as defective. This makes such a wide range of test possible of tubes that can be classed as good or satisfactory that many Diode types such as 6AL5, 6AV6, 6T8, 5T8, 1X2, 1B3, and many others will actually test with the meter going to full scale and bumping the stop.

As long as the meter pointer does not hit the stops hard enough to trip the protective relay, shutting off the tester. This condition is nothing to be alarmed about and the Diode under test can be considered good.

SERVICE NOTE No. 13

#68 Lamp

The #68 lamp is being removed from the circuit in all recent production and factory serviced units. This lamp and the 1/4 amp fuse essentially form duplicate protection for the IN91 diodes.

In most cases the fuse gives the best protection and in some instances undesirable leakage has been noted from the contacts to the base of the lamp.

Therefore (if replacement is required in the field,) it is recommended that the #68 lamp be removed and the socket contacts shorted with wire.

NOTE:

1. This lamp should not be replaced unless trouble is encountered in this circuit.

2. If the lamp is removed a short must be placed across the socket lead wires to complete the circuit.

3. The lamp should not be removed from testers unless the 1/4 amp fuse is wired in the circuit.

Replacement Parts List

Vickok Part Number	Description	Comments
110-7	Capacitor: Ceramic, .005 mfd, disc type, Centralab type DA-048-001A (-0+100% Centralab Distributor Part No. DD501	Symbol Numbers - C-302, C-303, C-304, C-305, C-306, C-401, C-403
250-72	Choke: Power, 4 henrys at 100 mils	Symbol Numbers - CR-403, CR-404
870-39	Crystal: paired IN91	
12270-35	Lamp: GE #47, 6-8V, .15 amp	Aged at factory
12270-15	Lamp: GE #68	
12270-22	Lamp: GE #51 Pilot	
12270-26	Lamp: NE-2 neon	Aged at factory
16925-222	Potentiometer: 1000 ohms, linear, taper, 1/2 watt, Centralab model #2, snap-in type	Low current balance Control #7
16925-244	Potentiometer: 10,000 ohms, 2 watt, wire wound, Chicago Telephone type 252	Bias adjust Control #1 Relay sensitivity control #8
16925-287	Potentiometer: 500 ohms, 2 watt, wire wound, Chicago Telephone type 252	Signal Regulation Control #10

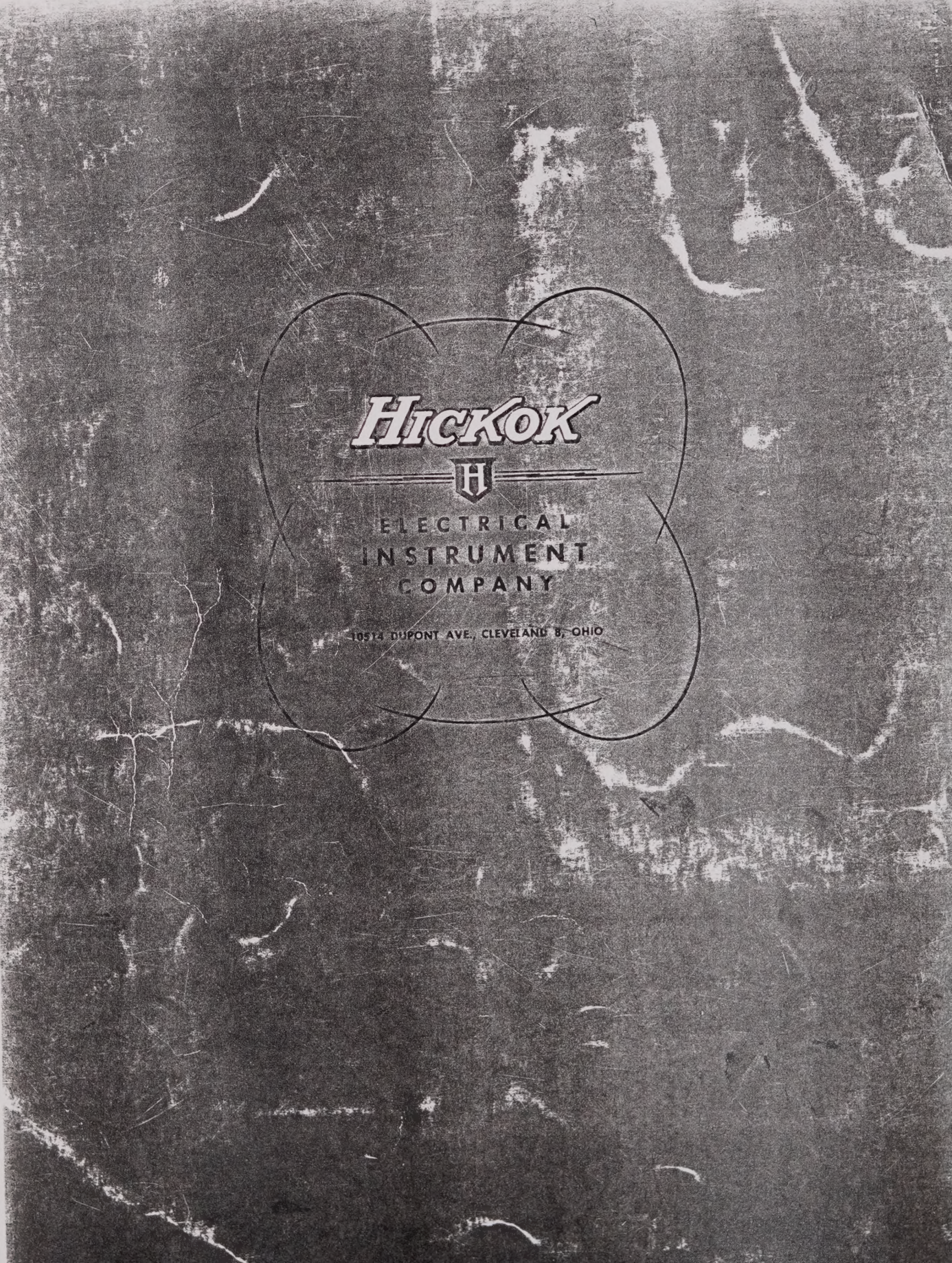
Replacement Parts List

The following is a list of parts which can be replaced in the field and a list of their corresponding Hickok part numbers.

Hickok Part Number	Description	Comments
3085-77 3085-38	Capacitor: electrolytic, 20-20-20-20 mfd. 450V, 1-3/8 x 3", supplied with insulating sleeve	
3085-78 3085-7	Capacitor: electrolytic, 20-20 mfd, 450V, 1" x 3" supplied with insulating sleeve	
3085-79	Capacitor: electrolytic, 1000 mfd, 40 volts 1-3/8 x 3" supplied with insulating sleeve	
3085-80	Capacitor: electrolytic, 1000 mfd, 6 volts 1" x 3" supplied with insulating sleeve	
3105-209	Capacitor: plastic, tubular, 0.1 mfd, 400 V, Astron Blue Point	
3105-226	Capacitor: paper, 4 mfd, 600 volts Astron supplied in 2 lug can.	

Replacement Parts List

Hickok Part Number	Description		Comments
16925-288	Potentiometer: 2 ohms, 2 watt, wire wound, Chicago Telephone type 252		High current balance Control #6
16925-289	Potentiometer: 50 ohms, 2 watt, wire wound, Chicago Telephone type 252		Signal amplitude Control #5
16925-290	Potentiometer: 1 megohm, ± 20%, 1/2 watt carbon, linear taper, Centralab Model 2, snap-in type		B+ voltage controls #2, 3, 4, and Centralab Distributor Part No. BX69
18537-72	Resistor: Deposited Carbon 1%	1280	Shunt A (R-207)
18537-71	Resistor: Deposited Carbon 1%	640	Shunt B (R-208
18537-70	Resistor: Deposited Carbon 1%	320	Shunt C (R-209)
18537-31	Resistor: Deposited Carbon 1%	160	Shunt D (R-210)
18537-69	Resistor: Deposited Carbon 1%	80	Shunt E (R-211)
18537-68	Resistor: Deposited Carbon 1%	40	Shunt F (R-212)
18539-2	Resistor: Deposited Carbon 1%	20	Shunt G (R-213)
18539-7	Resistor: Deposited Carbon 1%	10	Shunt H (R-214)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